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PHYSICS.—*The diffuse reflecting power of various substances.* W. W. COBLENTZ, Bureau of Standards. To appear in full in the Bulletin of the Bureau of Standards.

This paper gives an account of an investigation of the reflecting power of matte surfaces of various substances, for the spectral regions of 0.54, 0.60, 0.95, 4.4, 8.8, and 24μ. The diffusely reflected radiations were collected by means of a hemispherical mirror, and projected upon a surface thermopile of bismuth and silver, which was used to measure the intensity of the incident and reflected radiations.

The substances examined include lampblack, platinum black, pigments, white paints, green leaves, dyed cloth, and building material. The object of the investigation was to find the blackest and the whitest substances; the former to be used as absorbing surfaces of radiometers, the latter to be used as a covering for buildings exposed to intense sunlight.

Methods are given for preparing standard black surfaces; and quantitative data are given for the loss by reflection of the same. The blackest deposits of soot are obtained from an acetylene flame; the reflecting power being only about 0.6 per cent. Lampblack paint made by mixing the dry material with turpentine reflects about 3 per cent in the visible spectrum to 3.5 per cent in the extreme infra-red. Thick deposits of platinum black reflect about 1 per cent in the visible spectrum and 2 to 3 per cent in the extreme infra-red.

Bricks, granolith, dusty asphaltum pavements, and green leaves fall in the same group with a reflecting power about 25 per cent for green leaves. But there is a vast difference in their effect upon the surrounding atmosphere and consequently upon the comfort of the community. The building material continues to reradiate energy long after the sun has set, while in the growing leaf the absorbed energy is at once used in photo-chemical processes, with practically no rise in its temperature. It is evident that, until traffic demands the full width of it, a great portion of a street should be covered with grass and trees instead of granolith and asphalt, thus adding to the comfort of the community as well as decreasing the cost of maintenance. Observatories should be surrounded with grass and evergreen shrubbery which will absorb the solar rays without warming the atmosphere by reradiation.

As a covering for an observatory dome the problem is to find a white paint that reflects a maximum amount of visible rays and a minimum amount of infra-red rays of wave-lengths between 6 and 10μ. In this manner a large portion of the solar rays will be reflected into space; and the rise in temperature resulting from the solar rays that are absorbed will be prevented by reradiation, which is facilitated by a high emissivity (low reflectivity) at 6 to 10μ. Unfortunately the paint (zinc oxide) that fulfills the latter condition cannot be used for exterior work. The next best primary paint for exterior work is white lead. Radiometrically it would therefore be better to use a mixture composed of white lead and as high a proportion of zinc oxide as is permissible to form a good paint.

The carbonates, sulfates, and silicates have bands of strong metallic reflection in the region of 7 to 9μ, which suppresses reradiation of the absorbed solar rays. In binary mixtures, sulfates, and silicates are less desirable than carbonates; for their infra-red reflecting power is higher and the bands do not lie close to those of lead carbonate. This suppresses the emissivity over a wider range of the infra-red spectrum. Of course a few (5 to 8) per cent of silica or china clay which is said to improve white lead mechanically, cannot seriously affect the radiating

properties of the primary, viz., white lead. The combinations of calcium sulfate and of barytes with white lead appeared much darker than a similar combination with calcium carbonate.

The white paints examined quantitatively for reflection were samples which had been ground in linseed oil, under standard conditions.[1] There was no marked difference in the reflecting power of white lead made by different processes (American, Dutch, and French), the reflecting power of various samples varying from 74.3 to 76.0 per cent. Similarly the samples of zinc oxide paints reflected from 68 to 69 per cent. This agrees with previous observations on the dry pigments which show that lead carbonate has a higher reflecting power than zinc oxide. A mixture of equal parts of white lead and of zinc oxide reflected 71 per cent.

In view of the fact that the reflecting power of aluminum is high (69 per cent) in the visible and in the ultra-violet, it was of interest to determine whether sheet aluminum would be more satisfactory than white paint for protecting a building against warming by solar rays. The difference in reflecting power of aluminum and white paint is not so marked in the visible spectrum as in the infra-red. Both materials absorb considerable sunlight; but aluminum has the lower emissivity for radiations at 6 to 12μ. Hence it cannot radiate the absorbed energy as rapidly as the white paint and its temperature rises above that of white paint.

This conclusion is borne out by the following experiments in which the temperature of two similar plates of aluminum was observed before and after one plate was painted with white lead ground in pure linseed oil. Two sizes of sheet aluminum were tested; A = 46 by 48 by 0.718 mm., B = 68 by 69 by 0.245 mm. Thermocouples of copper and constantan wires were inserted and riveted in holes drilled thru the aluminum plates, and as a further attempt to obtain good contact the junctions were tightened with Wood's alloy. The constantan wire was 0.31 mm. and the copper wire was 0.40 mm. in diameter. The cold junctions

[1] Proc. Amer. Soc. for Testing Materials 11: 226. 1911.

were kept in ice. The aluminum sheets were mounted side by side upon a board of yellow poplar, 20 by 19 by 0.18 cm. and exposed to direct sunlight. The temperature of the pairs of sheets, A and B, and the difference in temperature was measured by means of a potentiometer.

Sheets No. II of both A and B were given two coats of pure white lead paint and when dry they were exposed to sunlight. The sky was perfectly clear (10–7–1912) with only a slight breeze blowing. Without glass coverings, which is the test of most interest, the bare aluminum plate was the hotter. For A–I, the temperature of the unpainted aluminum sheet was 3°.0 to 3°.1 higher than the exactly similar sheet having two coats of white lead paint. The actual temperature of A–I was about 44°.7. Similarly, for B–I the temperature excess of the unpainted aluminum sheet was 2°.3 to 2°.4, the actual temperature being about 43°.7. The intensity of the solar radiation, Q, was about 1.16 gr. cal. cm^2. min.

These tests were repeated using three coats of paint. The weather was perfectly clear (10–10–1912) and no breeze blowing. The intensity of the solar radiation was 1.157 gr. cal. cm^2. min. The plates were exposed directly to the sun, i.e., no glass intervening. For A–I the temperature excess was 4°.1 to 4°.3 the actual temperature being about 45°C. Similarly for B–I (unpainted aluminum) the temperature excess was 3°.0 to 3°.2, the actual temperature being about 42°.7.

From these tests it is evident that a metal roof painted with several coats of white paint is far superior to one of bright metal. As already mentioned this is owing to the fact that white paint has a higher emissivity than metals in the infra-red.

The unpainted sheets of aluminum (A–I, B–I) were then given three coats of zinc oxide paint. When thoroly dry, the sheets containing the zinc oxide paint appeared to be at about the same (+0°.1) temperature as obtained in the white lead. Another coat of paint was then applied (making four coats in all) to each sheet. When exposed directly to solar radiation, the temperature excess of the zinc oxide paint for the thin sheets, B, was ±0°.1 and for the thick sheets it was about +0°.5. From this appears that, in

comparison with white lead, what is gained in higher emissivity in the infra-red in the zinc oxide paint, is lost by its higher absorption (lower reflecting power) in the visible spectrum, so that radiometrically it is no more efficient than white lead.

The white lead paint was removed from the sheets, A–II and B–II, which were then painted with a matte layer of the lampblack used in the experiments already described. When exposed directly to the sun the temperature of the lampblack sheet A–II was about 16° higher than the zinc oxide paint, A–I; the actual temperature of the lampblack being about 52°.2 for solar radiation of intensity, $Q = 1.16$. Similarly the temperature of the lampblack sheet, B–II was 17°.5 higher than the zinc oxide plate B–I, the actual temperature of the aluminum sheet covered with lampblack paint being about 53°.3 C. and the room temperature being about 23°.1 C. The infra-red reflecting at 8.8μ differs but little for these two substances, hence, there is no great difference in their emissivities for low temperatures. In the visible spectrum the absorptivity of the zinc oxide is only about 30 per cent and for lampblack it is 97 per cent. Hence, the lampblack must become the hotter; for it absorbs energy at three times the rate, and it emits energy (low temperature radiation) at practically the same rate, as does the zinc oxide paint.

ELECTROCHEMISTRY.—*The silver voltameter. I.* E. B. Rosa and G. W. Vinal, Bureau of Standards. To appear in the Bulletin of the Bureau of Standards.

The earliest use of electrochemical decomposition as a means for the measurement of electricity appears to have been by Gay Lussac and Thénard[1] about 1811, but it remained for Faraday to enunciate the conditions on which it may be used for the exact measurement of current. He declared his gas voltameter to be the "only actual measurer of voltaic electricity which we at present (1833) possess." Because of this, he named it a "volta-electrometer." The earliest use of the silver voltameter of which we are aware was by Poggendorff in 1847. Since then, about

[1] These and other references will be given more in detail in the full paper and also the places where they may be found.

sixty papers dealing with this instrument have appeared, but the diversity of opinions as to the causes of the anomalous results obtained has been so great, that the present authors undertook in 1909 a systematic research to discover, if possible, the best conditions under which the voltameter might be used as a primary standard for the measurement of electric current. Before describing their own work, the authors give a short historical review of the subject up to 1909.

The years 1880 to 1886 were important because of the first series of absolute determinations of the electrochemical equivalent of silver. The first to be published was by Mascart, who measured his current by means of an absolute balance and obtained (corrected value) 1.1156 mg. per coulomb. The work of F. and W. Kohlrausch was in terms of the horizontal intensity of the earth's magnetic field. With their tangent galvanometers and several forms of voltameter, they obtained the final result 1.1183 mg. per coulomb. Lord Rayleigh and Mrs. Sedgwick investigated carefully the purity of their materials, the inclusions of mother liquor in the deposit, the effect of size of platinum dish the effect of temperature, and finally designed a type of voltameter that has been much used nearly down to the present time. Their values for the electrochemical equivalent were obtained with an absolute current balance. They found 1.11794 mg. per coulomb.

Thomas Gray in 1886 made an extended investigation both of the silver and the copper voltameters, but his form of instrument (two parallel plates in a glass beaker) has not been used by later investigators. A comparatively unknown paper by Novak, published in Bohemian in 1892, was probably the first to suggest the formation of a complex ion at the anode which yielded an excess of silver deposit on reaching the cathode. The same idea was probaly independently put forward by Rodger and Watson several years later, and again proposed and emphasized by Richards, Collins, and Heimrod in 1899. The latter made no absolute determination of the electrochemical equivalent, but on the hypothesis of the heavy anode ion determined corrections as to be applied to previous determinations, obtaining

1.1175 mg. per coulomb as the mean. They originated the porous cup voltameter, which was very satisfactory and has been much used since.

Kahle, in 1899, published the results of his extended researches on the voltameter. He noted a characteristic striated appearance of the deposit when the solution was used several times. The liberation of acid he concluded accompanied the formation of oxidation products at the anode. His value for the equivalent, using Clark cells as reference standards, was the same as found by the Kohlrausches. Leduc (1902) believed that the anode current density ought to be very small, so that the quantity of acid produced should be a minimum. He thought also that the presence of AgOH, *if in solution*, is not detrimental, and recommended neutralizing the electrolyte with Ag_2O. Mylius, in 1902, called attention to the possibility of producing a red silver precipitate by the action of filter paper on $AgNO_3$. The significance of this observation was apparently not appreciated until recently.

The first work at the Bureau of Standards on the voltameter was by Dr. Guthe in 1904, who compared several different forms and particularly noted the difference between the porous cup and filter paper voltameters.

Van Dijk in 1906, compared the porous cup and filter paper forms of voltameter, and found the difference to be 0.023 per cent, which he ascribed to the complex ion yielding an excess deposit in the former. He gives as the electrochemical equivalent of silver, 1.1180 mg. per coulomb. Duschak and Hulett obtained a high degree of reproducibility, and made a careful analysis of their deposits, finding inclusions amounting to about 0.011 per cent.

The important recent investigations of the national laboratories of England, France, and Germany have been published by Smith, Mather, and Lowry; Janet, Laporte, and de la Gorce; Jaeger and von Steinwehr, respectively. Absolute balances were used to measure the current in the first two, and in the last the voltage of the cadmium cell was determined on the assumption that the electrochemical equivalent of silver is 1.118 mg. per

coulomb. The English and French work was based on the filter paper voltameter.

The work of the present authors, carried out in 1908–09, is described in the first of a series of four papers. In the other three, in which Dr. A. S. McDaniel is a joint author, the continuation of the work during the years 1909–12 will be described. The second paper of the series will deal with the chemistry of the voltameter, and the theory of striated deposits, the third will treat largely of the purification and testing of materials, and give the second series of quantitative results, while the fourth and last paper will give the results subsequent to the International Technical Committee's work.

In this investigation, ten platinum and two gold dishes have been used; four large dishes (350 cc.), four medium (175 cc.), and four small ones (125 cc.). All the dishes of one size were adjusted to the same weight to facilitate the weighings, which were made on three balances (one for each size of dish) mounted on piers in a special constant temperature room, so arranged that the balances could be read by telescope and scale from outside the room. For weighing the dishes, similar ones reserved for tare were used, and the silver was counterbalanced by special silver weights, gold plated. Buoyancy corrections were thus eliminated. The types of voltameters used were (1) the Rayleigh or filter paper form, (2) the Richards or porous cup form, (3) the Poggendorff form without septum, excepting a glass cup, hung under the anode, or with silk around the anode, (4) the siphon type.

The deposits were timed automatically by a chronograph, and the ticks of a standard Riefler clock. The circuit was so arranged that the current could, after adjustment, be thrown on to the voltameter circuit and maintained constant to usually better than 1 in 100,000 during the course of the experiment. Particular attention was paid to the insulation resistance. The reference standards were a Wolff manganin coil of 1 or 2 ohms in oil, and four standard cells in an oil bath maintained at a fixed temperature. The drop in potential across the standard resistance was made equal to the voltage of one of the cells and kept so by

regulating the current. As a further check, a potentiometer was also included in the circuit. Our reference standards were frequently compared with the standards of the Bureau, and suitable corrections made.

The porous cups were of Pukal ware made by the Königlich Porzellan Manufaktur of Berlin. They were prepared by filtering dilute HNO_3 thru the pores, and, after eliminating the acid by distilled water, the cups were soaked in pure electrolyte. Between experiments they were kept submerged in electrolyte. After washing the deposits and replacing any loose silver, they were dried in an electric oven at 150°C. After cooling, they were placed in the balance case for several hours before weighing.

The first experiments were with the Rayleigh voltameter. As a mean of 37 experiments, the value 1.01866 volts at 20°C. for the Weston normal cell was obtained, assuming the electrochemical equivalent of silver as 1.11800 mg. per coulomb, as defined by the London Conference of 1908. A difference of about 40 parts in 100,000 was found between this and the porous cup form, the latter giving the lower value. It occurred to the authors that if this excess were due to the filter paper letting thru a complex ion, as supposed by Richards, doubling or trebling the thickness of filter paper ought to decrease the discrepancy. But it was found that using two or three sheets of filter paper had just the opposite effect, and also increased the striations which were soon found to be a sure indication of a heavy deposit. It was found that the excess of deposit in the filter paper form over that in the porous cup form depended on the amount of filter paper present, and that the porous cup voltameter gave the same high values as the filter paper form if filter paper were wrapped around the outside of the porous cup, or if the electrolyte had previously been contaminated by soaking filter paper in it.

When solutions were repeatedly used in a filter paper voltameter, the deposits were increasingly heavy with each electrolysis, but a similar experiment with the porous cup voltameter always gave the same weight or slightly lighter. To further test the complex ion theory, we tried re-electrolyzing some of the elec-

trolytes saved from inside the porous cups; this is the anode liquid which should give too heavy a deposit, if Richard's theory is correct. It was found, however, that if the electrolyte was *free from filter paper* the deposit was perfectly normal.

Many of the deposits were examined under the microscope, and also photographed. From pure electrolytes, the deposits were always crystalline and non-striated, and, indeed, the appearance of the deposit was found to be a good criterion of the purity of the electrolyte.

It was found that to produce a heavy deposit, it was not necessary to bring the electrolyte and filter paper together, but merely to make up the electrolyte with water that had stood over filter paper for a short time. It was evident that important chemical changes were produced in the electrolyte by th filter paper, and, accordingly, Dr. McDaniels joined us in the summer of 1909 to study the chemistry of the voltameter.

With the porous cup form, the authors obtained 1.018287 volts for the Weston normal cell at 20°, and this is very close to the final result, which will be given in the last paper of the series.

ZOOLOGY.—*The occurrence of nodes in the bathymetrical distribution of the recent crinoids.* AUSTIN H. CLARK.

Among the recent crinoids the most important of the faunal areas, the one to which all the other faunal areas are subsidiary and of which they appear to be derivatives, has a somewhat peculiar geographical distribution. From the Moluccas and the Lesser Sunda Islands it extends eastward past New Guinea, then southeastward to New Caledonia, Fiji, Samoa, Tonga and the Kermadec Islands, near New Zealand; reappearing at Hawaii it extends thence westward to southern Japan and southward along the Kuril Islands to Formosa; westward from the Lesser Sunda Islands it extends, by way of the Andamans and Ceylon, to the Mascarene Islands, Madagascar and southeastern Africa. It has sent two very distinct branches into the Atlantic, a northern and a southern; the former, from the Bay of Bengal, has spread thruout the Mediterranean and along the east Atlantic Coasts from the Gulf of Guinea to Norway; the latter, from southeastern

Africa, inhabits the region from Morocco to the Bay of Biscay, thence westward to and thruout the Caribbean Sea.

One of the interesting points in the distribution of this fauna is that it is absent from the central East Indian region north of Sumatra, Java, the Lesser Sunda Islands and the Moluccas, and south of Formosa and Japan. The connection between New Zealand and Hawaii is probably by way of eastern Oceania, a region as yet unexplored.

In plotting the bathymetric ranges of the species of this fauna occurring in the Indian and Pacific Oceans certain bathymetric altitudes of maximum abundance are noticeable, and these occur in the same positions among the Japanese, Hawaiian and Indian Ocean species.

Corresponding nodes occur in the Caribbean Sea, but the intervals between them are not so great. These nodes are (in fathoms):

	1	2	3	4	5
Indian and Pacific Oceans.....	0–50	100–150	300–400	750–900	1600–2000
Caribbean Sea.....		100–150	250–300	400–450	700–800

On examining the nodes in the Indian and Pacific Oceans it is at once evident that there is a certain regularity in their occurrence. If we should take 50 fathoms as our unit (a) and arrange hypothetical nodes according to the ascending powers of 2 we should find nodes at:

$$50\ (a):\ 200\ (2^2a):\ 400\ (2^3a):\ 800\ (2^4a):\ 1600\ (2^5a).$$

What we actually find are nodes approximately at:

$$a:\ 2\left(a+\frac{a}{2^2}\right):\ 2^2\left(a+\frac{2a}{3}\right),\ \text{or}\ 2^3\left(a-\frac{a}{2^3}\right),\ \text{or}\ 7a:\ 2^4\left(a+\frac{a}{2^3}\right),$$

$$\text{or}\ 18a:\ 2^5\left(a+\frac{a}{2^3}\right),\ \text{or}\ 36a.$$

Considering the paucity of our records and our exceedingly imperfect knowledge of the true maximum range of the species involved we appear to be justified in calling attention to the curious and striking approximation between our hypothetical nodes calculated according to the ascending powers of 2 and the nodes as we actually find them.

It is also evident that there is a similar regularity in the distribution of the nodes in the Caribbean Sea. If we should take 50 fathoms as our unit (a) and arrange hypothetical nodes according to the ascending powers of 2, plus 2 itself, we should find nodes at:

$$50\ (a):\ 100\ (2a):\ 200\ (2^2a):\ 400\ (2^3a):\ 800\ (2^4a).$$

It will be noticed that this arrangement is not greatly different from what we actually find.

Taking the whole ocean into consideration, the difference in temperature between 200 and 400 fathoms is 8°.3 Fahrenheit; between 400 and 800 fathoms 4°.5; and between 800 and 1600 fathoms 2°.1. In other words, the decrease in temperature is roughly in inverse proportion to the distances between the nodes. As temperature is one of the chief factors governing the distribution of marine animals it is quite probable that the spacing of the nodes is dependent upon it.

But the temperature decrease in the sea is represented by a regular curve, so that it cannot account for the original existence of the nodes. Their origin is probably to be sought in the answer to the problem concerning the origin of the deep fauna.

The fauna of the central East Indian or Malayan region is a heterogeneous mixture of species which in their distribution fall into five more or less distinct groups. This fauna in its bathymetrical distribution shows no nodes.

BOTANY.—*Papualthia Mariannae, a new species of Annonaceae from the island of Guam.* WILLIAM EDWIN SAFFORD, Bureau of Plant Industry.

Among the unidentified trees growing on the island of Guam mentioned by Don Felipe de la Corte[1] was one called by the natives *paipay*, the wood of which is used in the construction of small buildings and for handles of garden tools. I saw no specimen of this tree during my residence on the island; but I afterwards obtained herbarium specimens, including leaves and flowers, from Mr. H. L. W. Costenoble, and very recently I received specimens of its fruit from the venerable Monsignor José Palomo, for many years priest of Agaña, to whom I am indebted for many favors. The tree in question proved to belong to the Annonaceae and to the recently described genus Papualthia, which is characterized by leaves somewhat asymmetrical at the base and by shortly peduncled or subsessile, 6-petaled flowers, with the petals in two series, valvate and connivent, the inner petals slightly smaller than the outer or nearly equal to them in size; stamens indefinite; carpels indefinite to 3; ovules many to 2; and carpidia subglobose.[2]

This genus shows an affinity in its vegetative characters and flowers to certain species which King has placed in the genus Popowia, and also to several Malaysian species of Polyalthia, especially to the 2-ovuled group to which *P. subcordata* Bl., *P. macrorhyncha* Miq., and *P. celebica* Miq. belong. All of these have a tendency to asymmetrical leaves. Their petals are polyalthoid, but show a tendency toward shortening and to the connivence of the inner series, forming a transition from the true Polyalthias to the present genus, as pointed out by Diels.

Papualthia Mariannae Safford. sp. nov.

An irregularly branching tree, its very young ultimate branchlets clothed with ferrugineous silky solitary hairs, soon becoming glabrate, the older ones grayish, slender, bearing numerous minute

[1] Felipe de la Corte, Memoria descriptiva e historica de las Islas Marianas. Madrid, 1875.

[2] See *Papualthia* Diels n. gen. Engler's Botan. Jahrb. **49**: 138. 1912.

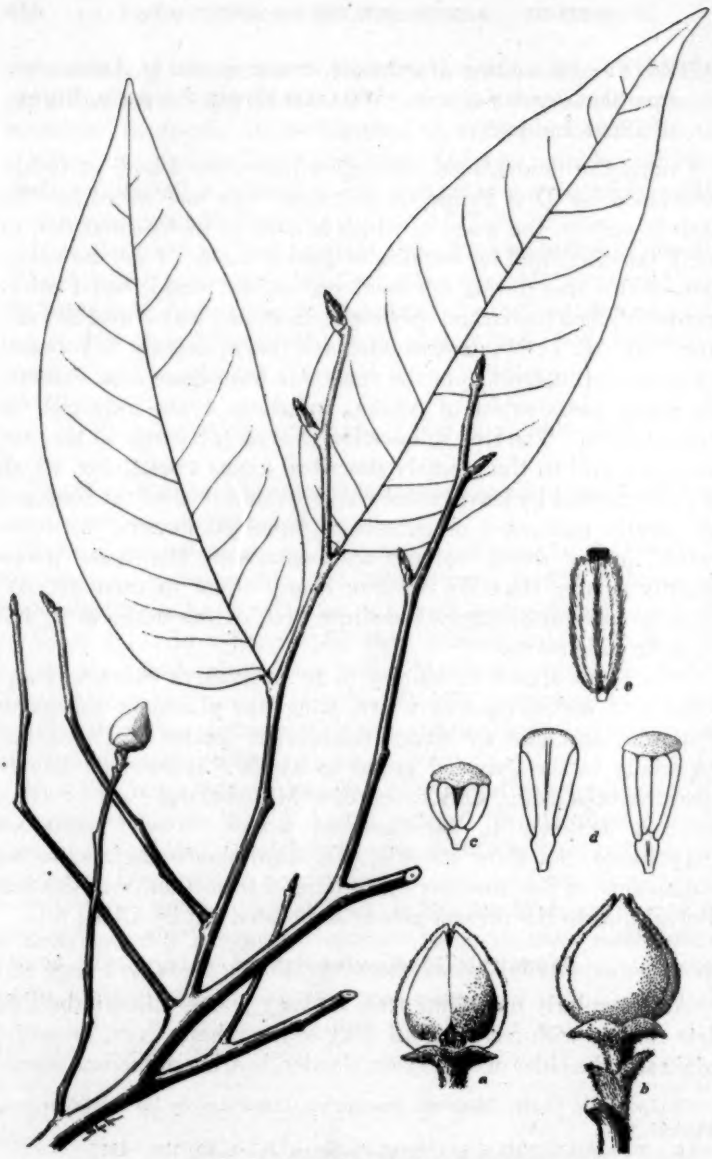

Fig. 1. *Papualthia Mariannæ* Safford

whitish lenticels. Leaves alternate, 2-ranked, entire, short-petioled, rounded and usually asymmetrical at the base, the uppermost ones lanceolate, acute or acuminate, the lower ones near the base of the branches usually smaller and broader, often ovate and obtuse, the blades glabrous and glossy above with impressed midrib, and glabrate beneath except near the base of the midrib which usually bears a few scant hairs. Flowers small, subglobose or broadly conical in bud; peduncles solitary subterminal on small branchlets, 1-flowered, short and thick, bearing two broad clasping bracteoles, which together with the peduncle

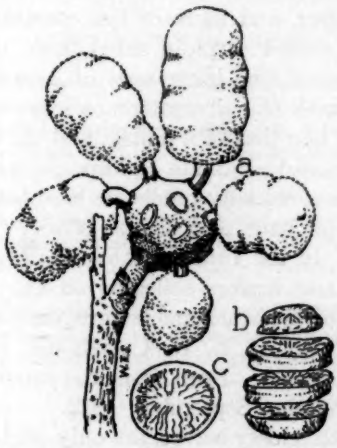

Fig 2. Fruit and seeds of *P. Mariannæ*

itself and the outer surface of the calyx are thickly covered with ferrugineous hairs; calyx 3-parted, the lobes broadly triangular; outer petals valvate, thick and coriaceous, broadly ovate, acute, appressed hirtellous on the outer surface, clothed with fine tomentum within; inner petals somewhat smaller, similar in shape and valvate like the outer ones, slightly clawed at the base, covered with fine dense tomentum. Receptacle (torus) convex or hemispherical, covered with fine stiff reddish hairs and bearing a large number of cuneate stamens closely crowded together, their

broadened connectives forming a continuous covering above the pollen sacs while the flowers are still immature; lower stamens shorter and relatively broader than the upper, subtriangular, the pollen sacs similar to those of other Annonas, adnate to the back of the broad filament and opening extrorsely by a longitudinal slit; the expanded connectives glabrous; carpels about 12, distinct, forming a cluster in the center of the mass of stamens, densely covered with appressed rufous hairs, and terminating in a short truncated stigma; fruit consisting of 8 to 12 shortly stipitate carpidia, globose to oblong, ovoid, or obovoid in shape, containing 1 to 4 seeds, granular on the surface, rounded or obtusely apiculate at the apex, and more or less constricted between the seeds; seeds of 1-seeded carpidia subglobose, those of 2-seeded carpidia hemispheroid, the inner ones of 3-seeded and 4-seeded carpidia discoid, with the circumference marked with a shallow groove, somewhat like that of a pulley, and the surface wrinkled, indicating the enclosed ruminate endosperm; mature torus spheroid borne on a short thick peduncle, its base bearing the remains of minute short stiff hairs and stamen scars.

Type material: In the United States National Herbarium no. 653784. Leaves and flowers collected on the Island of Guam, the southernmost of the Marianne Islands, on the Pago Road, east side of the island, by H. L. W. Costenoble, June, 1906 (Herb. W. E. Safford no. 1180). Fruit from the same locality received from Rev. José Palomo, September, 1912.

The thin, smooth, glossy leaves, are only slightly asymmetrical at the base. The petioles, which are hairy at first but at length become glabrate, are 4 mm. long, the blades of the larger leaves are 10 cm. long and 3.5 cm. broad, with 12 fine but distinctly marked lateral nerves on each side the midrib, more or less anastomosing before reaching the margin, with reticulating veins between them. The small cone-shaped flower-buds, which resemble those of *Annona glabra* in shape, are 8 mm. long and 7 mm. broad; the outer petals 8 mm. long and 5.6 mm. broad, and the inner ones 7.5 mm. long and 4.5 mm. broad. The lowermost stamens are 1.3 mm. long with the dilated connective 1 mm. broad, the upper stamens are 2.3 mm. long with the connective of the same

width as the lower ones. The carpels are about 2.3 mm. long and 1 mm. broad, and the stigmas, which are somewhat flattened and constricted at the base are about 0.5 mm. square. The mature carpidia owe the variation in their shape to the abortion or imperfect development of one or more of their ovules. Those with a single seed and globose in shape are about 1 cm. in diameter; the largest containing 3 to 4 seeds are 22 to 25 mm. long and 10 to 13 mm. in diameter.

Papualthia Mariannae is named in honor of Maria Anna of Austria, wife of Philip III of Spain, the patron and protector of the natives of Guam, for whom the Marianne Islands were named.

EXPLANATION OF FIGURES

Fig. 1. *Papualthia Mariannae* from type material, showing branches and leaves and a single flower natural size. *a*, flower with one outer petal removed, showing the 3 inner valvate petals covering the genital parts, with a few stamens visible between the somewhat unguiculate bases; *b*, subterminal flower, showing the two bracteoles on the peduncles; *c*, short stamen from the base of the androecium, *d*, longer stamens from the upper or inner part of the androecium, ventral and dorsal views, showing the two pollen sacs dehiscing by a longitudinal slit and capped by the transversely expanded connective; *e*, carpel, clothed with appressed hairs and terminating in a short broad truncated stigma. *a*, *b*, scale about 2.5; *c*, *d*, *e*, scale 10.

Fig. 2. The fruit of *Papualthia Mariannae*. *a*, spheriod torus bearing 5 carpidia and marked with scars made by the pedicels of fallen carpidia; *b*, seeds from a 4-seeded carpidium; *c*, discoid seed seen from above; all natural size.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this journal and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

CHEMISTRY.—*The atomic weight of bromine.* H. C. P. WEBER, Bureau of Standards. Bulletin of the Bureau of Standards, in Press.

A considerable amount of work has been done in order to determine the atomic weight of bromine, and the oft-repeated comparison of the atomic weights of silver and bromine makes it seem that this ratio is known with considerable accuracy. The value accepted for bromine, however, rests almost entirely upon that of silver, and it is of interest and importance to obtain a ratio between it and some other element. For chlorine a number of determinations of the ratio of hydrogen to chlorine in hydrochloric acid have been made, both by purely physical and by chemical methods. For bromine similar comparisons have not been made. Since the determination of the ratio chlorine: hydrogen was carried out with reasonable ease, it seemed probable that the method might be advantageously applied for the purpose of determining the ratio between hydrogen and bromine.

The method which was employed by Noyes and Weber[1] was found to give good results in this case. The initial difficulties to be overcome were somewhat greater, which was rather unexpected. They were largely due to the physical properties of hydrobromic acid gas and were eliminated after the method had been studied for some time and slight alterations in the method of manipulation had been introduced.

The results obtained are given in Table I. The column headed "discrepancy" gives the differences between H + Br and HBr. The remainder of the table is self-explanatory.

[1] Bulletin, Bureau of Standards, **4**: 345. 1908.

TABLE 1

EXPERIMENT	H	Br	HBr	DISCREPANCY	H : Br	H : HBr
	grams	*grams*	*grams*	*mg.*		
1	0.77300	61.28837	62.06052	−0.85	79.2863	80.2853
2	0.86060	68.25033	69.11144	+0.54	79.3055	80.3061
3	0.77607	61.54733	62.32198	−1.42	70.3064	80.3046
4	0.96927	76.88221	77.85135	−0.15	79.3197	80.3195
5	1.07545	85.29562	86.37092	−0.15	79.3114	80.3114
6	0.99689	79.06834	80.06424	−0.99	79.3150	80.3140
7	0.74966	59.45275	60.20500	+2.59	79.3063	80.3097
8	0.98161	77.85554	78.83758	+0.43	79.3141	80.3145
9	1.00131	79.39533	80.39658	−0.06	79.2915	80.2914
10	0.81983	65.02140	65.83867	−2.56	79.3108	80.3077
	9.00369	714.05722	723.05828	−2.63	79.3067 ±0.0022	80.3064 ±0.0018
					Combined	
					79.3066	±0.0014

In the 10 experiments 9.00369 grams of hydrogen were combined with 714.05722 grams of bromine and yielded 723.05828 grams of hydrobromic acid. The value obtained from these two sums is respectively 79.307 (1) and 80.306 (9).

The final ratio obtained from these figures for H : Br is 79.306 (7), with a probable error of 0.0022. The ratio found from H : HBr is 80.306 (4), with a probable error of 0.0018. Combining the two the value is 79.306 (6) ± 0.0014. The numerical value of the probable error is somewhat larger than that of the chlorine ratio obtained in a similar manner. Relatively it is approximately the same or even somewhat smaller.

Taking the atomic weight of hydrogen[2] as 1.00779, the value for bromine on the oxygen basis becomes 79.924, as against the value 79.920 given by the International Commission for 1912.

H. C. P. W.

[2] Clarke: Recalculation of Atomic Weights, p. 41, 1910.

REFERENCES

AGRICULTURE.—*Publications of the Bureau of Plant Industry, Department of Agriculture*, from January 1 to June 30, 1912, as follows:

Suggestions on growing Egyptian cotton in the Southwest. CARL S. SCOFIELD, Document 717. Pp. 10.

Distribution of cotton seed in 1912. LEON M. ESTABROOK and O. F. COOK. Document 716. Pp. 11.

Memorandum of information concerning official cotton grades. N. A. COBB. Document 720. Pp. 3.

Grain-sorghum production in the San Antonio Region of Texas. CARLETON R. BALL and STEPHEN H. HASTINGS. Bulletin 237. Pp. 30, figs. 4.

Suggestions to potato growers on irrigated lands. L. C. CORBETT. Circular 90. Pp. 6.

A preliminary study of the forced curing of lemons as practiced in California. ARTHUR F. SIEVERS and RODNEY H. TRUE. Bulletin 232. Pp. 38, figs. 4.

The pear and how to grow it. G. B. BRACKETT, Farmers' Bulletin 482. Pp. 31, figs. 30.

The cultivation and manufacture of tea in the United States. GEORGE F. MITCHELL. Bulletin 234. Pp. 40, pls. 2, figs. 11.

Crossbreeding corn. C. P. HARTLEY, ERNEST B. BROWN, C. H. KYLE, and L. L. ZOOK. Bulletin 218. Pp. 72, fig. 1.

Cooperative grain investigations at McPherson Kans., 1904–1909. VICTOR L. CORY. Bulletin 240. Pp. 22.

The thornless prickly pears. DAVID GRIFFITHS. Farmers' Bulletin 483. Pp. 20, figs. 4.

Sweet clover. J. M. WESTGATE and H. N. VINALL. Farmers' Bulletin 485. Pp. 39, figs. 16.

Diseases of cabbage and related crops and their control. L. L. HARTER. Farmers' Bulletin 488. Pp. 32, figs. 7.

Two dangerous imported plant diseases. PERLEY SPAULDING and ETHEL C. FIELD. Farmers' Bulletin 489. Pp. 29, figs. 3.

The profitable management of the small apple orchard on the general farm. M. C. BURRITT. Farmers' Bulletin 491. Pp. 22, figs. 8.

The more important insect and fungous enemies of the fruit and foliage of the apple. A. L. QUAINTANCE and W. M. SCOTT. Farmers' Bulletin 492. Pp. 48, figs. 21.

Lawn soils and lawns. OSWALD SCHREINER, J. J. SKINNER, L. C. CORBETT, and F. L. MULFORD. Farmers' Bulletin 494. Pp. 48, figs. 19.

Alfalfa seed production. J. M. WESTGATE, ROLAND MCKEE, and M. W. EVANS. Farmers' Bulletin 495. Pp. 36, figs. 14.

Cotton improvement under weevil conditions. O. F. COOK, Farmers' Bulletin 501, Pp. 22.

Seeds and plants imported during the period from January 1 to March 31, 1911: Inventory No. 26; Nos. 29328 to 30461. Bulletin 233. Pp. 98.

Seeds and plants imported during the period from April 1 to June 30, 1911: Inventory No. 27; Nos. 30462 to 31370. Bulletin 242. Pp. 99.

Farm management: Organization of research and teaching. W. M. HAYS, ANDREW BOSS, A. D. WILSON, and THOMAS P. COOPER. Bulletin 236. Pp. 96, pls. 5, figs. 57.

Cost and methods of clearing land in western Washington. HARRY THOMPSON. Bulletin 239. Pp. 60, figs. 25.

The diseases of ginseng and their control. H. H. WHETZEL and J. ROSENBAUM. Bulletin 250. Pp. 44, pls. 12, figs. 5.

The use of artificial heat in curing cigar-leaf tobacco. W. W. GARNER. Bulletin 241. Pp. 25, figs. 4.

Results of boys' demonstration work in corn clubs in 1911. BRADFORD KNAPP and O. B. MARTIN. Document 741. Pp. 7, figs. 2.

Selection of cotton and corn seed on southern farms. BRADFORD KNAPP. Document 747. Pp. 8, figs. 4.

Emergency crops for overflowed lands in the Mississippi Valley. BRADFORD KNAPP. Document 756. Pp. 8.

The corn crop in the Southern States. BRADFORD KNAPP. Document 730. Pp. 12, figs. 2.

The agricultural possibilities of the Canal Zone. Part I, Reconnoissance soil survey. HUGH H. BENNETT. Part II, The outlook for agriculture. WILLIAM A. TAYLOR. Report 95, Office of the Secretary. Pp. 49, pls. 12, fig. 1.

The adulteration and misbranding of the seeds of red clover, Kentucky bluegrass, orchard grass, and hairy vetch. B. T. GALLOWAY. Circular 39, Office of the Secretary. Pp. 7.

The control of cotton wilt and root-knot. W. A. ORTON and W. W. GILBERT. Circular 92. Pp. 19, figs. 12.

The danger of using foreign potatoes for seed. WILLIAM STUART and W. A. ORTON. Circular 93. Pp. 5.

The seed-corn situation. C. P. HARTLEY. Circular 95. Pp. 13, figs. 2.

Title Page and Contents, Bulletins of the Bureau of Plant Industry Nos. 218 to 226, Inclusive, 1911–1912, Volume XXIX. Pp. 16.

Title Page and Contents, Bulletins of the Bureau of Plant Industry Nos. 227 to 230, Inclusive, 1911–1912, Volume XXX. Pp. 9.

Title Page and Contents, Bulletins of the Bureau of Plant Industry Nos. 231 to 240, Inclusive, 1912, Volume XXXI. Pp. 15.

The history and cause of the coconut bud-rot. JOHN R. JOHNSTON. Bulletin 228. Pp. 175, pls. 14, figs. 10.

The structure and development of crown gall: A plant cancer. ERWIN F. SMITH, NELLIE A. BROWN and LUCIA MCCULLOCH. Bulletin 255. Pp. 60, pls. 109, figs. 2.

The nematode gallworm on potatoes and other crop plants in Nevada. C. S. SCOFIELD. Circular 91. Pp. 15, figs. 21.

The measurement of the oxidase content of plant juices. HERBERT H. BUNZEL. Bulletin 238. Pp. 40, pls. 2, figs. 9.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE BOTANICAL SOCIETY OF WASHINGTON

The 82d meeting was held at the Cosmos Club October 17, 1912. Mr. W. E. Lamb of the Forest Service was elected to membership. The following papers were read:

The cotton of the Hopi Indians: F. L. LEWTON. This paper will be published in full in the Smithsonian Miscellaneous Collections.

A botanical trip to the Sevier Forest, southern Utah: W. W. EGGLESTON.

Damping-off of coniferous seedlings: C. P. HARTLEY. With the exception of the cedars, damping-off of seedlings is a serious hindrance to the raising of conifer seedlings. Surfacing beds with gravel tends to decrease the trouble. The disease is generally worst under moist conditions, but a well drained nursery in dry climate in southwestern Kansas has suffered especially heavy loss from damping-off parasites. No positive control method has ever been developed for general use.

In western porous soils damping-off is simply a root-rot of very young seedlings, which may attack at any point from the ground surface to several inches below. Seedlings several weeks old may have the younger parts of their roots rotted and yet survive.

Pythium debaryanum appears to be the most dangerous parasite in western nurseries. *Rhizoctonia sp.*, *Fusarium sp.*, and probably *Trichoderma lignorum*, also cause damping-off. Pythium and Rhizoctonia have been successfully inoculated on autoclaved soil, but inoculations do not succeed uniformly on unsterilized soil, due probably to competition of bacteria and other fungi. Rhinzoctonia loses parasitism in culture and different strains vary greatly in virulence.

All active Pythium in nursery soil can be killed very cheaply by means of fungicides. Heat, and fungicides which break down soon after application, such as mercuric chloride, or acids and copper salts followed by lime, are not effective in the west, because Pythium often reinfects such disinfected soil, running thru it rapidly before seedlings raised on it develop resistance. This reinfection at least sometimes takes place thru the air, and is difficult to prevent under nursery conditions. Excellent results have been obtained by treating beds before seeding with sulfuric acid and formalin, and on alkaline soils with zinc chloride and copper sulfate. These fungicides seem to leave a slight residue in the soil which protects against reinfection. This

protection sometimes fails. Rather complicated watering methods are necessary in the west to prevent chemical injury to the germinating seed by fungicides which leave residues. Further work is required to place any of the treatments on a firm economic basis.

W. W. STOCKBERGER, *Corresponding Secretary.*

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 462th regular meeting of the Anthropological Society of Washington, D. C., was held in the New Museum Building, Washington, on October 15, 1912.

Major Richard Sylvester, Superintendent of Police for the District of Columbia, read a paper on *Criminal characteristics.* He reviewed the history of crime and pointed out that as civilization progresses the cruder crimes, such as homicide, tend to give place to subtler forms, such as forgery or embezzlement. The general government, he continued, has been urged to establish a national bureau of criminal identification, but such cooperative work has been left to the heads of American police departments.

There are practical difficulties in establishing a standard for the normal human being and in the distinction of criminals therefrom; for the police tests are applied only to those who have broken the law and many are non-criminal simply from lack of occasion. Moreover, many cases of apparent criminality are due to mental defect or disease.

The popular impression of the criminal as hungry and furtive is erroneous. The average man who makes crime a business in large cities is fairly prosperous and has no fear of arrest. Some of the anatomical characteristics which Lombroso thought decisive of criminality are common in the lower races of man, whether criminal or not. Measurements in general give racial rather than criminal characteristics.

Descriptions of a number of criminals charged with murder were compared in detail with the result of showing many varieties of human appearance bracketed together.

Some special kinds of crime are associated with peculiarities of appearance and develop these, but the criminal does not usually differ in appearance from other people. Stress was laid on the importance of circumstances beyond the control of the individual as largely determining the category to which a man belongs.

The paper was discussed by Drs. Hrdlička, Frank Baker, Hough, Glueck and others. The first two emphasized the unreliability of external peculiarities, relied on by Lombroso and others, and of every sort of test which has been devised for general distinction. Dr. Hrdlicka insisted that crime is a matter of the nerves and brain, or that the mentality and criminal characteristics may be more due to organs and parts which are hidden than to the obvious and chiefly irrelevant external ones which Lombroso depended upon for his diagnosis. Dr. Hough explained tattooing as devoid of significance in primitive conditions, but in civilization as a survival indicative of some weakness that might

predispose to crime. Dr. Glueck referred to his experience in charge of the criminal branch of the Government Hospital for the Insane and to the necessity of learning all about a man's past and about his circumstances and behavior at every stage of his life rather than trusting to his behavior or condition at the time of any one act as a proof of criminality.

A special meeting of the Anthropological Society was held at 4.30 p.m., October 29, 1912, in the National Museum, the President, Mr. Stetson, in the chair.

Dr. I. M. CASANOWICZ read a very interesting paper on the Mithra cult, explaining it as a religion of redemption, which for several centuries was the most important competitor of Christianity. It was Aryan in origin, antedating the separation of the Aryan people of India from the Iranians, and was transferred westward by stages, accumulating elements in the Mesopotamian valley and the Mediterranean basin, but preserving an Iranian nucleus. It entered Rome as the religion of the poor and lowly, but was taken up by society when found helpful to imperial policy and made its first convert of an emperor in Commodus. Mithra was essentially the god of light, hence of truth and benevolence; and from the antithesis of light and darkness grew the conception of his war against the powers of evil. Zoroaster built his system on this duality and conflict, though relegating Mithra to a lower place. Later he came to be regarded as occupying a middle place (on earth) between the powers of heaven and the evil powers of the underworld, serving also as a mediator between man and the unapproachable supreme deity. The cult of Mithra, he said, had influenced Christianity, especially in the conceptions of the powers of evil, the efficacy of sacraments and the procedures of the church.

WM. H. BABCOCK, *Secretary.*